MODERNIZATION OF HEAT SUPPLY SYSTEM OF RAILWAY STATIONS

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ABSTRACT

The article considers the need to modernize the heat supply system of railway stations within the framework of the main guidelines of the energy strategy of the Russian Federation until 2030. The main park of boiler rooms is equipped with the aged machinery that by some features does not meet the standards of environmental friendliness, safety and efficiency. The article presents the main indicators of boiler rooms of a new type. The comparative analysis of the characteristics of the new and former boiler rooms as of an energy complex is suggested. The conformity of the proposed indicators to the guidelines of the energy strategy of the Russian Federation and subsequent innovations is determined. One of the conclusions of the authors is that in addition to replacing the equipment, it is necessary to conduct decentralization of the station's heat supply system.

Keywords: energy efficiency, operating costs, steam boilers, reserve fuel, fuel oil, diesel, block-modular boiler rooms, efficiency.

Background. *Modern problems of stationary power engineering of transport system of railways (as an energy complex) pose the task of the evolutionary process of its modernization in general and of boiler equipment in particular, not only as a source of thermal energy, but also as of a particular energy system. Railway stations must meet the basic requirements of the energy strategy of the Russian Federation until 2030 [1–3]. The main targets of the strategy are: energy security; energy efficiency of the economy; budgetary efficiency of energy consumption; ecological safety of power engineering. In this regard, it becomes urgent to review the ongoing modernization with definition of its main directions and technical, environmental and economic indicators to be achieved.*

Objective. *The objective of the authors is to consider modernization of heat supply system of railway stations.*

Methods. *The authors use general scientific and engineering methods, comparative analysis, evaluation approach, mathematical methods, scientific description.*

Results.

1. Boiler rooms subject to modernization.

Typical boiler rooms heat industrial and administrative premises, supply steam and hot water for a complex of production and technical buildings of railway consumers. Typically, in a standard boiler room, steam boilers of the type DKVR-20–13 of 1975 year of production – 2 pcs and E-6,5–1,4 GM of 1992 year of production – 1 pcs are installed. They use fuel oil. Reserve power source is not provided. The auxiliary equipment of the boiler rooms has a high percentage of wear.

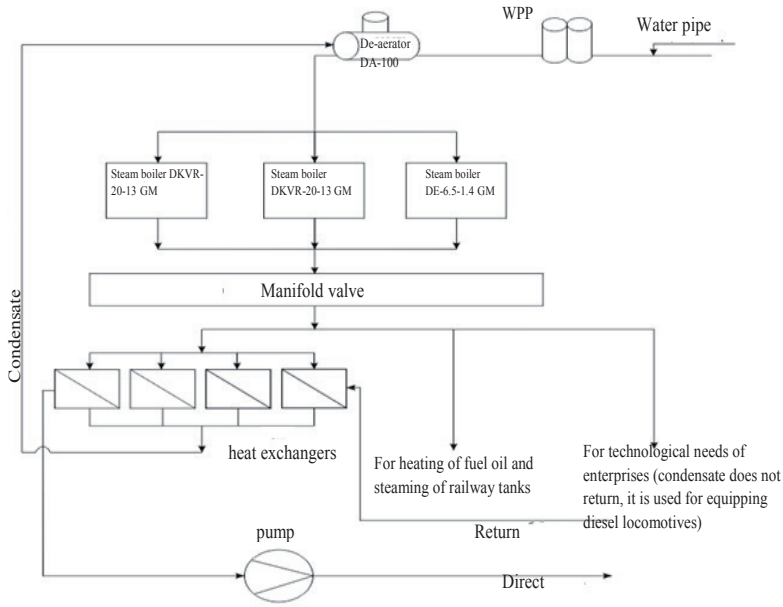
The heat supply system for consumers of the enterprise is two / three-tube (two pipes – supply/ return of heating water for heating, ventilation, the third pipe – transfer of steam for technological needs without return of condensate). The transfer of steam and heating water is carried out through pipelines with overground (about 95 %) and underground type of gasket lined with thermal insulation of mineral wool (60 %), asbestos crumb and foam polymer insulation (10 %). The total length of such heat networks is 9085 meters, the total length of the pipelines is 7105 meters. Fuel oil facilities is a complex of devices that ensure acceptance, storage and supply of the necessary amount of fuel oil in the boiler room, and its preparation for combustion in boiler furnaces. Fuel oil can be main fuel, reserve (for example, in winter), emergency, ignition, when the main one is a solid fuel burnt in a pulverized state. To supply fuel oil to the boilers, three schemes are used: circulating (using high-viscosity fuel oil, when the boiler room works constantly on fuel oil and for a short time on gas); dead-end (when burning low-viscosity fuel oil, when the boiler room works on stable loads exceeding the average); combined (when the boiler room works on variable loads and frequent transitions from gas to fuel oil). The regulation of the supply of fuel oil (pressure) is carried out by means of a valve with a pulse through the capacity of the boilers or the vapor pressure in the boiler.

As can be seen from the table above, three boilers with a total thermal output of 46,5 t/h are installed in the boiler room. As it is written above, there is no reserve fuel. The large extent and deterioration of the networks entail large expenditures on energy resources and maintenance. The DKVR boiler is

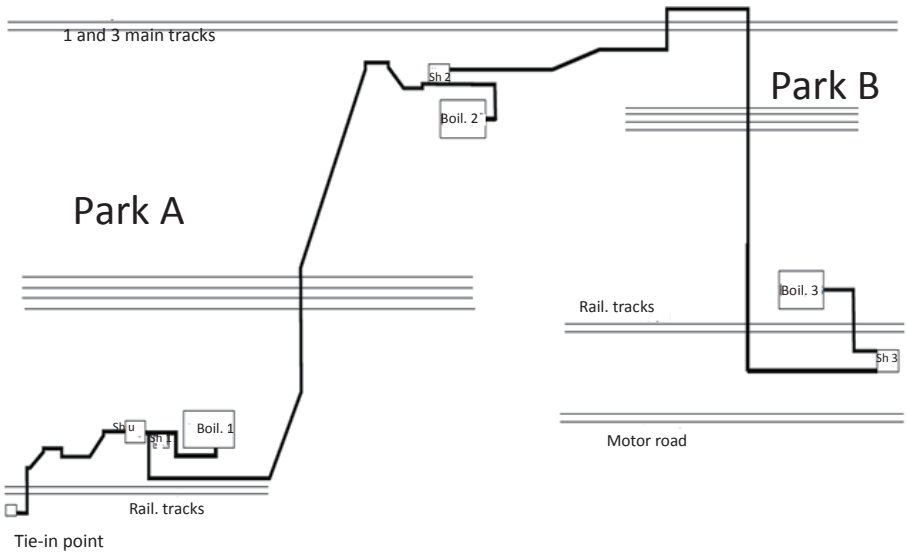
Table 1

Main equipment

№	Type of a boiler	Type of burners (furnaces)	Type of fuel	Year of commissioning	Design capacity t/h	Pressure kg/cm^2	Temperature dir/ret °C	Efficiency
1	2	3	4	5	6	7	8	9
1	DKVR-20–13 GM	Spray burner	Fuel oil	1972	20	13	130	89 %
2	DKVR-20–13 GM	Spray burner	Fuel oil	1973	20	13	130	89 %
3	E-6,5–1,4 GM	Spray burner	Fuel oil	1992	6,5	10	130	89 %



Pic. 1. Thermomechanical scheme of fuel oil boiler room.



Pic. 2. A new modular heat supply scheme for railway stations.

equipped with stairs and platforms for convenient maintenance. Steam boiler DKVR-20–13 GM is a vertical water tube boiler with a shielded combustion chamber and a boiling beam, which are made according to the design scheme «D». A distinctive feature of this scheme is lateral location of the convective part of the boiler relative to the combustion chamber

Thus, an analysis of the existing heat supply scheme has shown that a large length, deterioration of equipment and networks entail large expenditures on energy resources and maintenance. Therefore, modernization requires not only the replacement of equipment, but the need for decentralization of the station's heat supply system.

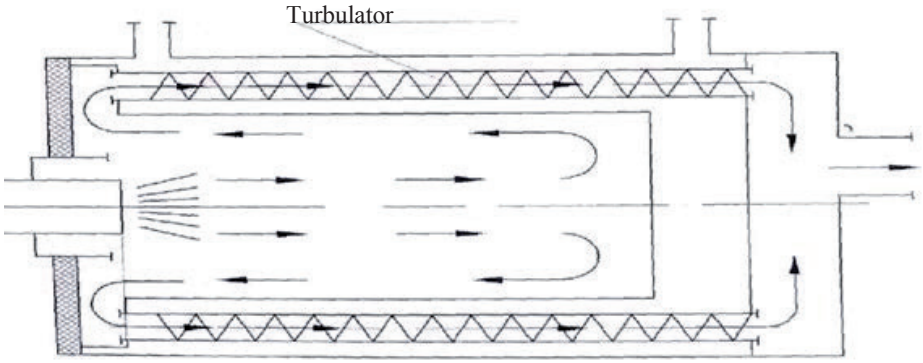
2. Modernization of heat supply system of a typical station

The technological and ecological efficiency of modernization [4–6] could be achieved through different approaches. In the city of Moscow it was decided to proceed with the closure of fuel oil boiler rooms to reduce losses in transportation of thermal energy, improve the efficiency of heat generation and reduce the cost of generating heat. In the framework of the resource saving actions it is envisaged to build three gas block-modular boiler rooms, shown in Pic. 2: Boiler room No. 1 «Desna-1900» with a heat capacity of 1,9 MW is proposed to be installed in the area of the park «A»; Boiler room No. 2 (Central boiler room) with a heat capacity of 9,0 MW is proposed to be

Table 2

Main technical characteristics of new boiler rooms

№	Name of a parameter	Meas. units	Boiler rooms		
			№ 1	№ 2	№ 3
1	Brand of block-model installation	–	BKU-1900	BKU-9000	BKU-1000
2	Boiler room category according to reliability of heat supply	–	second	second	second
3	Nominal heat output	–	1900	9000	1000
4	Main type of fuel	–	natural gas	natural gas	natural gas
5	Thermal scheme of boiler rooms	–	two-circuit	two-circuit	two-circuit
6	Type of boilers	–	hot water	hot water	hot water
7	Boiler circuit	–	closed	closed	closed
8	Initial water pressure	MPa	0,2	0,2	0,2
9	Coefficient of efficiency, not less than	%	92	92	92



Pic. 3. Scheme of movement of gases in the boiler.

installed next to the fuel depot of the Desna-9000 station; Boiler room No.3 with a rated capacity of 1,0 MW is proposed to install for steam consumers «B». The new heat supply system is designed to produce heat energy in the form of hot water for heating and ventilation, technological needs and hot water supply to provide the railway infrastructure of the station with them.

The implemented block-modular boiler rooms operate in an automatic mode without maintenance personnel. The alarm signaling about the emergency situation is transmitted via SMS messages to the cellular phones of emergency dispatch personnel. Module № 1 and № 3 work only in winter (seasonal) for heating. Module No. 1 removes heat to 12 buildings, module No. 2 removes heat to 32 buildings, Module No. 3 removes heat to 14 buildings. Periodic inspection and maintenance of the boiler room is carried out by emergency dispatch personnel from the staff of the liquidated boiler room, the location of which is envisaged in the existing production and service premises of the operating enterprise. The main characteristics of modular boiler rooms are given in Table 2.

Apparently, the adopted modernization option provides an increase in technical efficiency, by increasing the efficiency to 92 %. The main reason for increasing the efficiency of the boilers is the new boiler arrangement. Boiler Polykraft Duotherm [7] water-heating fire-fumigation with reversible furnace is made in block design. The efficiency of the boiler room is increased due to the new fuel atomization system – spray burner, which provides the best mixture formation when working on gas fuel. This spray burner, in the case of operation on reserve fuel, provides the necessary fineness of the spraying of diesel fuel before its ignition, thus ensuring a better combustion completeness of the mixture and a more eco-friendly exhaust, in comparison with the previous fuel oil equipment. Also, the efficiency of the boiler increases due to the use of artificial intensification of heat transfer by installing a turbulator in the boiler. In addition, the new boiler rooms are equipped with alarms for technological equipment and monitoring the content of CH and CO, closing the pipeline gas supply with a valve in an emergency situation, which significantly increases the safety of boiler rooms. The lining of the boiler is lightweight, using mineral wool mats. The shell of the boiler is metallic. The boiler operates on natural gas or light fuel oil (depending on the type of a burner). The design of the boiler is made in a gas-tight design and operates under supercharging.

The economic efficiency of modernization is explained by a decrease in the operating costs of the boiler rooms, the results are given in the table.

Table 3

Results of reduction of operating costs

№	Indicators	Measurement unit	Value of the indicator before introduction (basic heating system)	Value of the indicator after introduction (new heating system)	Change of the indicator, (–decrease) (+increase)
1	Annual labor costs, including social contributions	rub.	8 115 448,39	–	–8 115 448,39
1.1.	Annual expenses for labor payment of the boiler room	rub.	6 242 652,61	–	–6242652,61
1.1.1.	Annual fund of working hours of the boiler room for a reporting period	hours	31 536,00	–	–31 536,00
1.2.	Annual expenses for allocations for social needs of the boiler room	rub.	1 872 795,78	–	–1 872 795,78
2	Fuel	rub.	36 904 692,00	16 609 313,99	–20 295 378,01
2.1.	for other needs	rub.without VAT	36 904 692,00	16 609 313,99	–20 295 378,01
2.1.1.	fuel oil	rub.without VAT	36 904 692,00	–	–36 904 692,00
2.1.1.1.	fuel oil	tons	6 150,78	–	–6 150,78
2.1.1.2.	natural gas	rub.without VAT	–	16 609 313,99	16 609 313,99
2.1.1.3.	natural gas	m^3	–	3 194 098,84	3 194 098,84
3	Other material costs	rub.without VAT	2 030 000,00	1 000 000,00	–1 030 000,00
3.1.	Annual expenses for maintenance of a fuel oil warehouse	rub.without VAT	700 000,00	–	–700 000,00
3.2.	Annual costs for repair and maintenance of the boiler room	rub.without VAT	1 330 000,00	1 000 000,00	–330 000,00
4	TOTAL reduction of costs	rub.without VAT	47 050 140,39	17 609 313,99	–29 440 826,40

Conclusion. *As a result of consideration of the issue of modernization of the heat supply system (boiler room) of the railway station, it is determined that not only replacement of worn equipment is required, but also decentralization of the thermal system of the entire station. In addition, the efficiency of the heat source of the modernized boiler room is determined by the change in the type of fuel on which boilers operate. The efficiency of new boiler rooms with diesel fuel is 3 % (92 %) higher than that of boiler rooms operating on fuel oil (89 %). That is, the proposed modernization of the boiler room of the railway station corresponds to the main provisions of the energy system, which must meet the requirements of the energy strategy of the Russian Federation until 2030: energy security; energy efficiency of the economy; budgetary efficiency of energy consumption; ecological safety of power engineering. It should be noted, however, that there are ways of additional innovations in the form of utilization of the exhaust energy of the boiler room with subsequent formation of a closed energy cycle.*

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